INFORMATION BULLETIN 2

U.S. BUREAU OF RECLAMATION
Information on

KESTERSON RESERVOIR AND WATERFOWL

U.S. Bureau of Reclamation
San Luis Unit
Central Valley Project
California

February 1984

The San Luis Unit Special Study—An Overview

The west side of the San Joaquin Valley from Kettleman City north to the Sacramento–San Joaquin Delta encompasses approximately 1.2 million acres of farmland. Most of this land has been irrigated for more than 40 years, predating operation of the Central Valley Project. The project now provides water to most of these lands in the San Luis Unit and Delta-Mendota Canal service areas. A total of 253,000 acres are now affected by inadequate drainage of salts and leaching water that accumulate in the soil above impermeable clay layers. The land needing drainage will increase to 345,000 acres by the year 2020 and 493,000 acres by 2095, about 40 percent of the land within the service areas.

In the absence of a long-term solution to the drainage problem, irrigated crops will become increasingly threatened by both drainage and salt-disposal problems. Farming will become increasingly uneconomical as productivity is reduced. As farms go out of business, service industries and the local tax base will decline, unemployment and the demand for public assistance will rise, and some people will have to leave the area to find work. These local effects will in turn be felt on a smaller scale in the regional and State economies, which are also closely tied to agriculture. A continuation of discharge of agricultural drainage into the San Joaquin River from the Delta-Mendota Canal service area, together with reduced flows from east-side streams, will contribute to water quality degradation and affect downstream beneficial uses of the river. These effects will be felt within the valley and the Delta region.

The Bureau of Reclamation will soon complete its San Luis Unit Special Study and present the results of this study in a Special Report and Draft Supplement to the Final Environmental Statement for the San Luis Unit of the Central Valley Project in California. The study addresses the adverse effects of salt accumulation and inadequate drainage in the San Joaquin Valley. The special report will evaluate alternatives and recommend solutions to the agricultural drainage and salt management problems in the study area.

Study results to date point to Delta disposal of the agricultural drainage water as the preferred method for solving the problems associated with salt accumulation and degradation of the San Joaquin River's water quality. This plan proposes completion of the San Luis Drain to Suisun Bay. Included in the plan are a series of reservoirs along the drain alinement to contain accidental toxic spills into the canal and for storage of water for discharge during seasons of minimum impact.

The other alternatives considered in the study are no action, in-valley evaporation, and desalting. The no-action plan serves as a baseline against which the action plans are evaluated. This plan provides for limited construction of drainage facilities by individual farmers but no overall, coordinated plan among farmers and no participation or financial contribution by the Federal Government.

The in-valley evaporation plan provides for discharge of the subsurface drainage water to evaporation ponds in the San Joaquin Valley. Through onfarm drains and collectors, subsurface drainage flows would be transported to 13 evaporation ponds along the length of the service area. One cell in each evaporation pond would be dried each year, permitting removal of the concentrated salts to an ocean-disposal site.

Desalting and subsequent disposal through solar brine ponds is a variation of the in-valley evaporation alternative. Unlike the other alternatives, the desalting plan would retain the salts in the valley. Accumulation of the salts in the solar brine ponds would require 156 square miles (100,000 acres) of land in 100 years for storage.

United States Department of the Interior
BUREAU OF RECLAMATION
MID-PACIFIC REGIONAL OFFICE
2800 COTTAGE WAY
SACRAMENTO, CALIFORNIA 95825

IN REPLY
REFER TO: MP-780
320.

February 13, 1984

Enclosed for your information is a copy of our Information Bulletin 2 on Kesterson Reservoir and Waterfowl. This is the second of several bulletins planned by the Bureau of Reclamation which will share with the public the results of our San Luis Unit Special Study and answer questions about actions proposed to preserve agricultural lands in the San Joaquin Valley, improve surface water quality, and--where possible--enhance environmental values.

Agricultural drainage water discharged into the existing segment of the San Luis Drain and stored in Kesterson Reservoir contains high concentrations of the trace element selenium. These high selenium concentrations are the probable cause of very high incidences of mortality and developmental abnormalities recently discovered among waterfowl hatchlings and embryos at the reservoir. This bulletin answers some basic questions about the selenium problem at Kesterson Reservoir, its effects on waterfowl, and the steps being taken to solve the problem.

Sincerely yours,

John H Turner

John H. Turner
Acting Regional Planning Officer

Enclosure

Dear Californian,

This information bulletin—the second in a series—has been prepared to promote understanding about salt management issues affecting San Joaquin Valley agriculture and the environmental quality of the San Joaquin River and the San Francisco Bay-Delta Estuary. Salt management problems in the valley began to develop before the turn of the century with the advent of irrigated agriculture. The buildup of salts in valley soils has adversely affected agricultural land on the west side of the San Joaquin Valley, and discharges of drainage water from a portion of these lands are degrading the quality of the San Joaquin River. Proposals to collect these salts from farm fields and transport them to the estuary for disposal have raised concerns about the quality of the environment throughout the valley and in the estuary.

High incidences of mortality and developmental abnormalities recently discovered among waterfowl at Kesterson Reservoir are believed to be the result of high levels of selenium in agricultural drainwater stored in the reservoir. This bulletin answers some basic questions about the selenium problem at Kesterson Reservoir, its effects on waterfowl, and the steps being taken to solve the problem. We are interested in your views on this important matter. You can respond by using the coupon provided or by writing us at the address shown on the coupon.

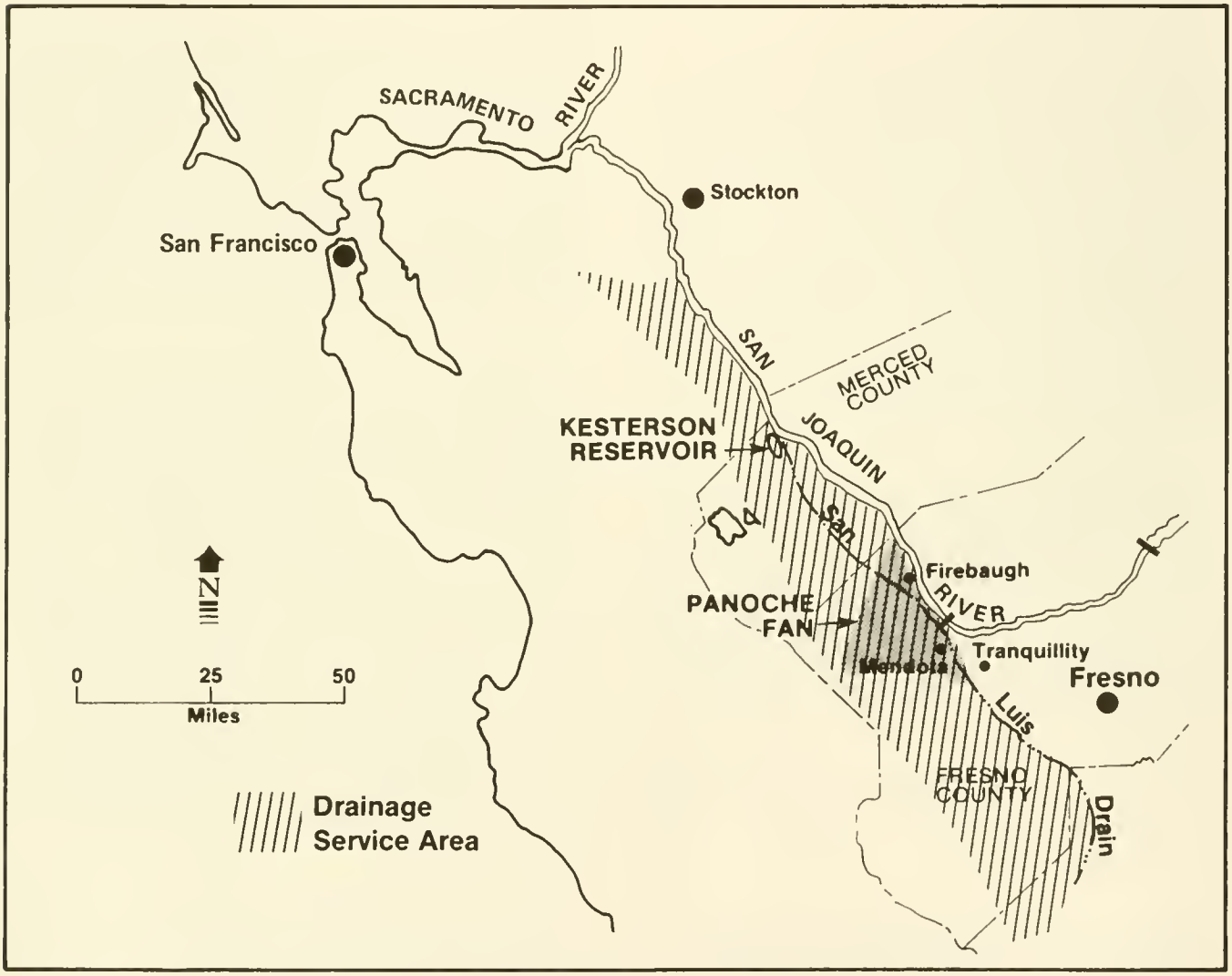
INTRODUCTION

Kesterson Reservoir is located just east of Gustine at the terminus of the existing portion of the San Luis Drain. The reservoir was built by the Bureau of Reclamation in 1971, and consists of 12 shallow ponds with a total water surface area of about 1,200 acres and an average depth of 4 feet. The reservoir was designed originally to regulate flows in the San Luis Drain for ultimate discharge into the western Delta at Suisun Bay. It presently serves as a storage and evaporation facility for about 7,000 acre-feet annually of agricultural drainage water from about 8,000 acres of land west of Mendota. These lands are located within the San Luis Unit in an area known geologically as the Panoche Fan.

Agricultural drainage is an important source of water for wetlands and wildlife management areas on the west side of the valley. Kesterson Reservoir has been managed as part of the Kesterson Wildlife Management Area by the U.S. Fish and Wildlife Service (FWS) since 1972. Between 1974 and 1978, the water discharged into the reservoir consisted mostly of surface water from local sources, the quality of which approximated that of applied irrigation water. Increasing amounts of drainage water began flowing into the reservoir in 1978 as subsurface drains were installed and the drainage from them was discharged into the San Luis Drain. Since 1981 most of the inflow to Kesterson Reservoir has consisted of drainage water.

A great need exists in the San Joaquin Valley for wetland areas to support a variety of fish and wildlife. Agricultural drainage is one of the more available, inexpensive sources of water for the maintenance of wetlands. In 1982 the FWS began an investigation to determine the suitability of subsurface agricultural drainwater from the existing segment of the San Luis Drain for use in managing waterfowl habitat. Water and fish samples collected from the San Luis Drain and Kesterson Reservoir were analyzed. Comparison tests were also made at the State's Volta Wildlife Management Area, a nearby area which receives most of its water supply directly from the Delta by way of the Delta-Mendota Canal. Results indicated that concentrations of most trace elements and all pesticides measured were nearly identical at the three sites and did not approach dangerous levels. However, selenium concentrations in fish from the drain and Kesterson Reservoir were as much as 100 times higher than those from Volta.

A subsequent review of published research revealed that high concentrations of selenium cause mortalities and deformities in chicken and turkey embryos. Although no abnormalities had been observed in waterfowl at Kesterson Reservoir, the FWS was concerned that bird embryos there could be affected. Field observations made by the FWS in the spring of 1983 showed very high incidences of mortalities and deformities at the reservoir among newborn coots, grebes, stilts, and ducks. These findings revealed for the first time that high selenium concentrations in California soils could pose a serious problem for waterfowl.



KESTERSON RESERVOIR AND PANOCHE FAN

WHAT IS SELENIUM?

Selenium is a naturally occurring, nonmetallic trace element closely associated with volcanic deposits that contain sulfur. Selenium can exist in four forms, each with different physical, chemical, and toxic properties.

Selenium forms are dependent upon environmental conditions, and the process of transformation from one form into another is complex and not yet fully understood. Only recently have analytical methods been developed to identify the inorganic chemical forms of selenium in water.

In soils, selenium exists as selenide, selenite, or selenate. Selenate is the most water soluble form and is commonly found in alkaline soils. Selenide and selenite are normally transformed into selenate in natural aerated water, but this is a slow process. The fourth form, elemental selenium, is an insoluble solid in natural waters. Therefore, all four forms are often found in the aquatic environment.

Selenium, like many other elements, accumulates in plants and in organisms such as plankton, invertebrates, fish, birds, and mammals. Existing information indicates that aquatic organisms assimilate selenite more quickly than selenate. Within an organism, both selenate and selenite are transformed into selenide, which in turn is incorporated into important life-sustaining chemicals.

Very little is known about the toxicity of the different selenium forms. Some selenium interactions with other elements have been documented. For example, elements such as arsenic, antimony, copper, germanium, and tungsten can reduce selenium toxicity. Conversely, selenium can reduce the toxicity of arsenic, cadmium, mercury, silver, and thallium in organisms. These known, but not well understood, interactions complicate the assessments of toxic levels of selenium in waterfowl.

Selenium is known to be beneficial at moderate concentrations. It is necessary in the diet of all animals, including humans. It is a critical element in protein production and is considered essential to embryo development. Some scientists and dieticians believe that elements such as selenium, in proper amounts, can prevent cell damage and may help prevent cancer. Although small amounts of selenium are important to good health, consumption of high concentrations of this mineral can be toxic.

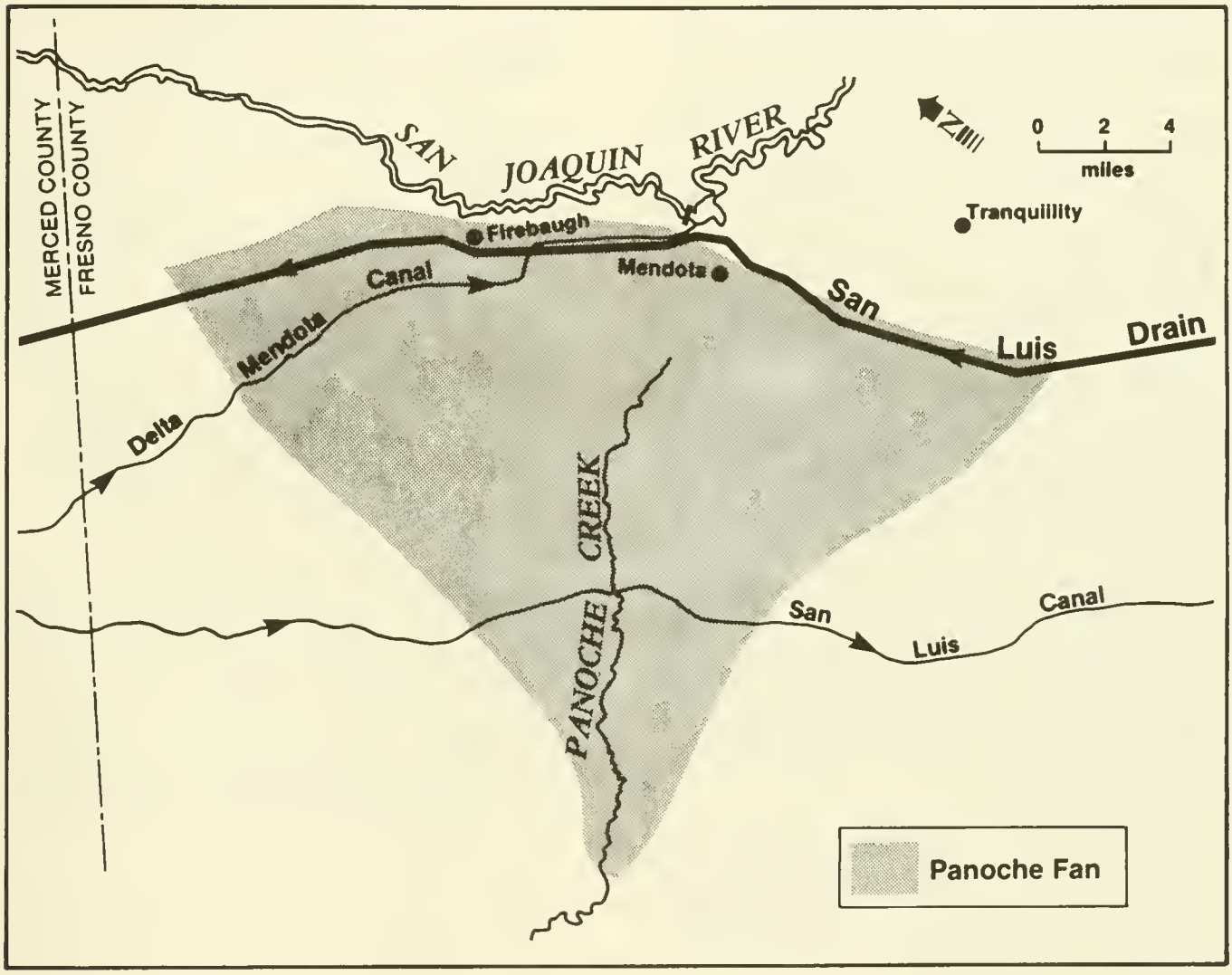
In many areas selenium is added to animal diets. For example, on the east side of the San Joaquin Valley, where there is little natural selenium in the soil, farm animal diets are supplemented with sodium selenite. Humans get selenium mainly in their food, and dietary supplements are available commercially.

WHERE DOES THE SELENIUM COME FROM?

Selenium is found at the lower elevations of the west side of the San Joaquin Valley. It is believed to have accumulated on the valley floor from the erosion of marine soils found in parts of the Coast Ranges.

High concentrations of selenium have been found in the shallow ground water (5 to 10 feet below the surface) along the lower edge of the alluvial fan of Panoche Creek. The Panoche Fan encompasses about 220,000 acres of land, most of which is used for irrigated agriculture. About two-thirds of the fan area is known to contain high selenium levels. The rest of the west side of the valley between Tracy on the north and Kettleman City on the south is believed to contain from 1 to 10 percent of the concentrations measured in the fan.

To more accurately determine the distribution of selenium and other trace elements in the drainage service area, data are being collected from approximately 110 monitoring sites in the San Luis Unit and Delta-Mendota Canal service areas. Most of these sites are located in the area south of Firebaugh, where the greatest drainage problems are expected to occur. Sampling will continue at least through the fall of 1984.


MERCED COUNTY
FRESNO COUNTY
SAN JOAQUIN RIVER
Firebaugh
Mendota
Tranquillity
0 2 4
miles
Canal
Mendota
Delta
San Luis Drain
PANOCHE CREEK
San Luis Canal
Panoche Fan

PANOCHE FAN

HOW DOES SELENIUM AFFECT WILDLIFE?

High concentrations of selenium are the probable cause of the high incidences of mortality and abnormalities among waterfowl chicks at Kesterson Reservoir. Much higher than normal percentages of deformed or dead hatchlings were found during the field observations in 1983, and a high proportion of unhatched eggs contained dead or deformed embryos. Of the 347 nests observed, 20 percent had deformed birds. The deformities included chicks with no eyes, no legs, or no wings; deformed legs, feet, or wings; deformed beaks; and edemic (swollen) heads. Approximately 40 percent of the eggs contained dead embryos. The coot eggs analyzed had about 10 times the concentration of selenium commonly found in eggs of waterfowl elsewhere. Also, the number of juvenile birds observed at the reservoir was much lower than would normally be expected. Concentrations of selenium in adult birds were high, although no mortalities were observed. The highest levels of selenium measured in any of the waterfowl at the reservoir were found in adult coots.

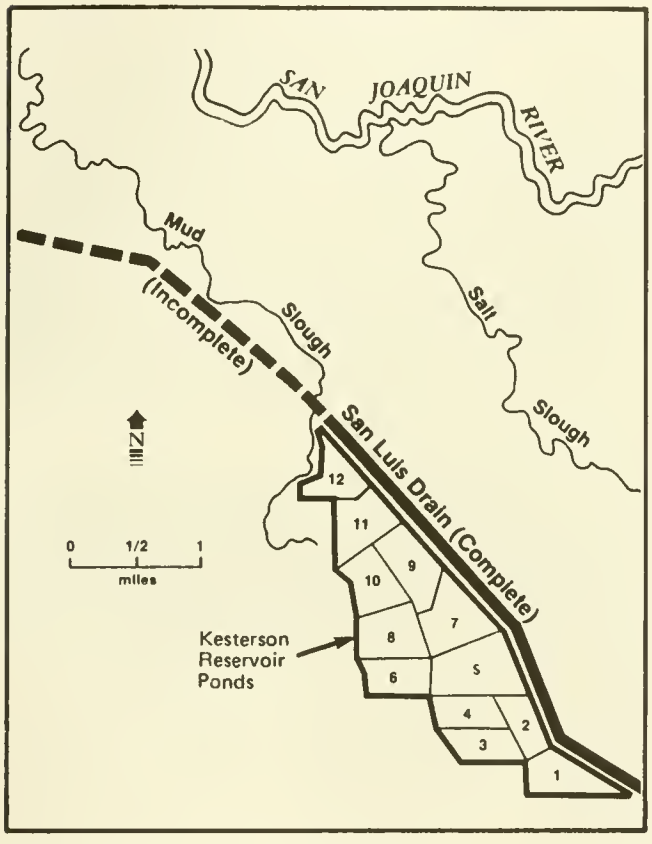
Selenium biologically concentrates through the food chains leading to birds. Selenium accumulates in small fish and plants grown in the reservoir area; thus, the food eaten by the waterfowl is thought to be the main source of selenium concentrations in adult birds.

There is concern that high concentrations of selenium could have adverse effects on mammals, including humans, who eat the birds. At the suggestion of the State Department of Health Services, a warning has been posted by the Department of Fish and Game at the Kesterson Wildlife Management Area cautioning hunters to limit their consumption of coots.

IS THE PROBLEM UNIQUE TO KESTERSON RESERVOIR?

We don't know yet. The potential for trace element effects as severe as those observed at Kesterson Reservoir was unforeseen when the San Luis Drain was built. Much of the land now known to have high selenium levels has been irrigated for 30 to 40 years. It is some of the finest farmland in the world. Subsurface agricultural drainage water from this land has sustained popular wetland areas in the valley for many years. A large expanse of existing wetlands known as "the grasslands" receives agricultural drainage from both the Panoche Fan and other areas, which are not known to have high levels of selenium in the soil.

Except for the field observations at Kesterson Reservoir, the FWS has not examined the selenium impact on waterfowl hatching success in the grasslands, other private wetlands, or any other Federal or State wildlife management areas on the west side of the valley. As part of an interagency effort to resolve the selenium problem, the FWS plans to conduct surveys this spring and summer of some of these wildlife habitat areas.



KESTERSON RESERVOIR

WHAT IS BEING DONE ABOUT THE PROBLEM AT KESTERSON RESERVOIR?

Several steps are being taken to address the selenium toxicity problem at Kesterson Reservoir.

A monitoring program is being conducted to evaluate the effect of water storage in Kesterson Reservoir on adjacent lands and surface and subsurface water supplies. Eighteen surface sites and 81 shallow ground-water sites are being monitored for a variety of physical and chemical data. Merced County, where Kesterson Reservoir is located, has tested several domestic water supply wells near the reservoir and found selenium concentrations to be at safe levels.

Six of the twelve ponds which compose Kesterson Reservoir are being maintained in their present state by the Bureau to allow the FWS to continue essential research studies, including additions to the research data base established in 1983 on bird hatchings. Vegetation in the other ponds will be removed this summer to the extent feasible, and the depth of water within individual ponds will be maintained at a level to discourage waterfowl from feeding on seeds and plants and from nesting in the area.

In December 1983 the Bureau, in cooperation with the FWS and the U.S. Geological Survey (GS), sponsored a 3-day conference of scientists to explore available information related to selenium. About 30 scientists from 8 universities and 7 governmental agencies were invited to participate. Additionally, about 70 individuals from government, private organizations, and the media attended the conference.

Four main topics were discussed at the meeting: (1) effects of selenium on wildlife, (2) geochemical characteristics of selenium and other trace elements, (3) proper chemical analysis for toxicants in water, sediments, and organisms, and (4) avian toxicology. These topics were selected to focus discussion on the problem at Kesterson Reservoir and other sites that could be similarly affected, and to provide direction for further study. A report on the conference, "Summary Report: Conference on Toxicity Problems at Kesterson Reservoir," was published in January 1984 and distributed to the participants.

As a result of the conference, an interagency research and action program has been initiated by the Bureau, FWS, and GS to analyze the effects of selenium and other trace elements on the ecosystems of the valley and the estuary. Other Federal and State agencies will be asked to participate in this program, which will examine the mechanisms by which trace elements concentrate in living things, the sources of trace elements, and ways to reduce unsafe concentrations to safe levels. The goal of the program is to develop an effective way of managing waterborne trace elements to protect fish and wildlife.

Several long-term solutions to the selenium toxicity problem have already been suggested. These include diffusion of drainage water that reaches the estuary, isolation of drainage from selenium-laden soils for special treatment, stopping irrigation of selenium-laden soils, dilution of drainage water with a freshwater supply, and dilution of high-selenium drainage with low-selenium drainage. Other possible solutions may be identified in the interagency studies.

HOW DOES THE PROBLEM AFFECT AGRICULTURE?

Subsurface drainage water resulting from the irrigation of 1.2 million acres of farmland in the Central Valley must be removed to keep the lands productive. Also, an alternative to agricultural discharges to the San Joaquin River is needed to enhance the water quality of the river, which currently serves as a drainage outlet for about 600,000 acres of land north of Mendota.

The State Water Resources Control Board is expected to evaluate all information about selenium toxicity to determine measures necessary to ensure that the discharge will not harm fish and wildlife resources. The selenium problem needs to be better understood to determine what levels will not be harmful.

If information shows that safe levels cannot be met in the discharge, then the water, as well as the salts and trace elements it contains, would have to be stored on valley lands, or it must cease to be generated. Because of the high costs of the in-valley evaporation and desalting alternatives and the potential hazards associated with them, some of the agricultural lands requiring drainage probably would not be drained and would eventually go out of production, resulting in severe adverse economic effects. The costs of these alternatives are 50 to 150 percent greater than the cost of the Delta disposal alternative. Possible contamination of surface- and ground-water supplies from the leaching of brine water associated with land storage could significantly affect both usable water supplies and agricultural land. In addition, large amounts of farmland would be dedicated for storage of the salts, and the surface ponds required to store and evaporate the drainage water probably would attract large numbers of migratory and resident birds, which could result in waterfowl toxicity problems similar to those occurring at Kesterson Reservoir.

WHERE DO WE GO FROM HERE ON THE SELENIUM PROBLEM?

It will take several months, perhaps even years, to conclude the studies required to identify the best measures to solve or minimize any existing or potential selenium problem within the San Luis Drain service area. The results of the studies will be made public when they become available. It is anticipated that the State Water Resources Control Board will prescribe operational limitations to ensure that trace element concentrations in drainage discharges are sufficiently restrictive to protect the aquatic environment.

The drainage facilities currently proposed would not be in operation before 1995. Consequently, sufficient time remains to take any additional steps necessary to ensure the protection of fish and wildlife resources that could be affected by the project. Decisions made by the Bureau on project facilities will be sufficiently flexible to allow changes as more is learned about the control of trace element problems. Also, the board will review a discharge permit, if it is granted, at least every 5 years to ensure that it is still adequate in protecting the beneficial uses of the estuary.

WHAT HAPPENS NEXT?

The Bureau is actively seeking to share the results of its studies and answer questions about its proposals. A Summary of the Draft Special Report and Draft Supplement to the Final Environmental Statement for the San Luis Unit will be available for public review in the spring. The next bulletin in this series will discuss the four alternatives considered in the study. Bulletins following these will discuss specific issues and concerns including project costs and financing; land severance required for the drain; seepage from the drain; and the impacts of the drain on fish and wildlife, municipal and industrial water supplies, and recreation opportunities in the Delta.

If you would like to receive a copy of the Summary Document and have not already requested it, please complete the enclosed coupon and return it to the Bureau of Reclamation. Please notify the Bureau of other individuals interested in receiving copies of the bulletins.

Thank you for taking the time to read this information bulletin. We expect to develop additional bulletins in the near future which will address other issues in more detail, as an aid to informed public decisions regarding the San Luis Drain.

Other bulletins in this series include Information Bulletin I on Drainage and Salt Disposal, published in January.

Clip Here and Detach

(Please print or type)

Check one of the following, detach the card and mail.

☐ I would like to receive a copy of the Summary Document.

☐ I am most interested in:

_____

_____

_____

☐ Please add the following person(s) to your mailing list:

_____ _____

_____ _____

_____ _____

To insure proper handling, please fill in your name, address and zip code in the return address space.

Address Correction Requested ☐

Return Address:

_____

_____

_____

Place
Stamp
Here

U.S. Bureau of Reclamation
MP-780
2800 Cottage Way
Sacramento, CA 95825

P00001945

Special Study
San Luis Unit
Central Valley Project
Mid-Pacific Region
Bureau of Reclamation
U.S. Department of the Interior
2800 Cottage Way
Sacramento, CA 95825